

U.S. Patent Application Serial No. 10/821,089  
Filed: April 19, 2004, Inventor: James Wagner Larsen  
For: Systems and Methods Useful For Detecting Presence  
And/Or Location Of Various Materials  
Attorney: James F. Ewing IV, Telephone: 404.815.6494  
Attorney Docket No. 14088/299978  
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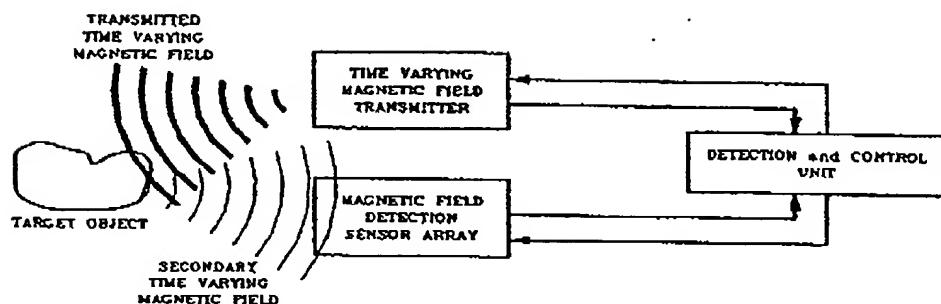
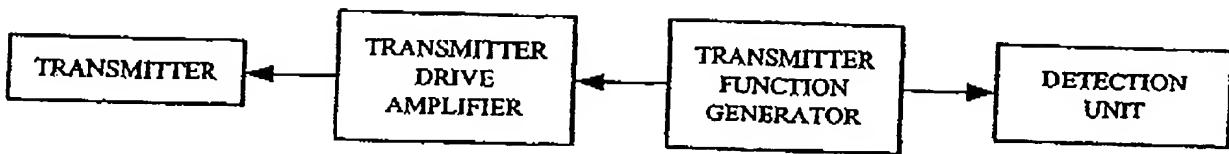


FIGURE 1-1 SYSTEM BLOCK DIAGRAM

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**FIGURE 1-2**  
**TRANSMITTER WITH KNOWN OUTPUT FUNCTION**

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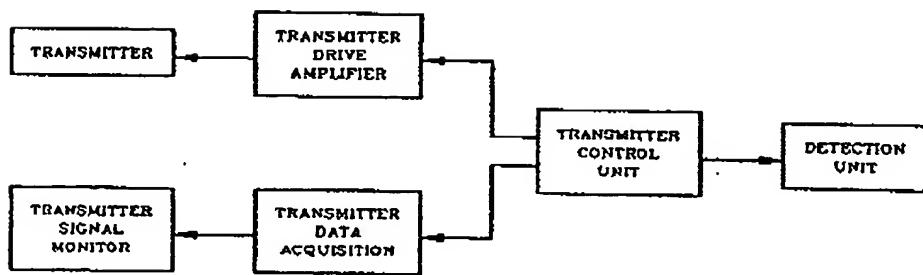


FIGURE 1-3  
TRANSMITTER WITH MAGNETIC FIELD MONITOR

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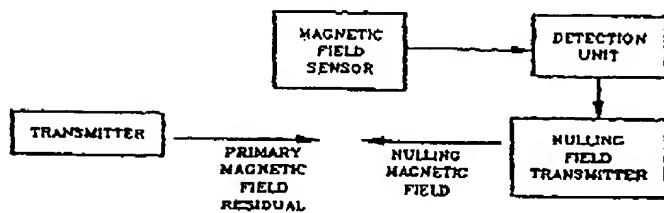


FIGURE 1-4A  
 RESIDUAL MAGNETIC FIELD NULLING  
 USING A NULLING MAGNETIC FIELD

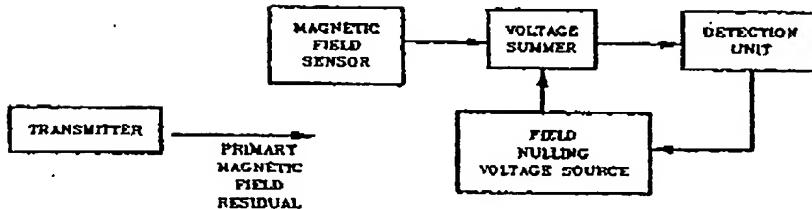


FIGURE 1-4B  
 VOLTAGE NULLING OF RESIDUAL FIELD SENSOR OUTPUT

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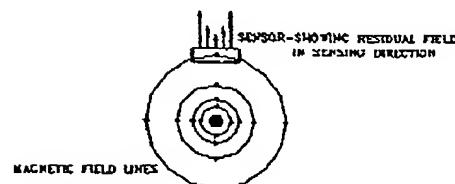


FIGURE 1-5A  
TRANSMITTER COIL CROSS SECTION FOR SINGLE WIRE COIL  
SHOWING SENSOR POSITION AND RESIDUAL FIELD

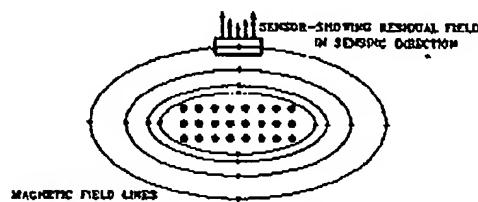


FIGURE 1-5B  
TRANSMITTER COIL CROSS SECTION FOR NORMAL RECTANGULAR COIL  
SHOWING SENSOR POSITION AND RESIDUAL FIELD

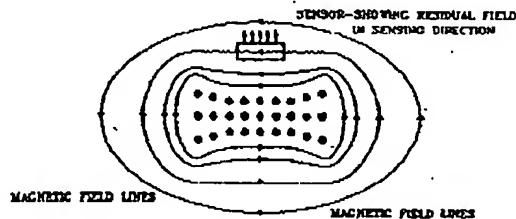


FIGURE 1-5C  
TRANSMITTER COIL CROSS SECTION FOR SHAPED COIL  
SHOWING SENSOR POSITION AND RESIDUAL FIELD

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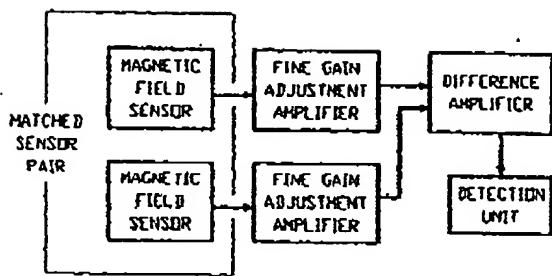


FIGURE 1-6  
GRADIENT SENSING USING A MATCHED SENSOR PAIR

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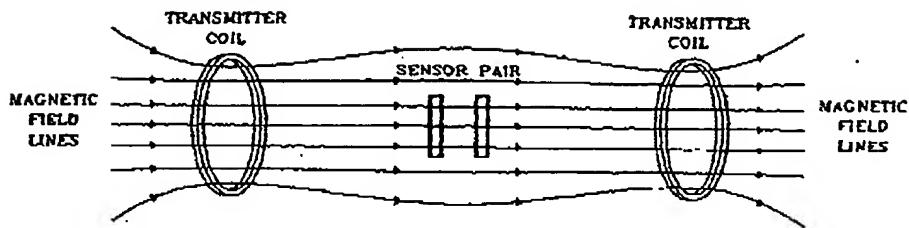


FIGURE 1-7  
SENSOR PAIR CALIBRATION  
USING TWO TRANSMITTER EQUAL COILS

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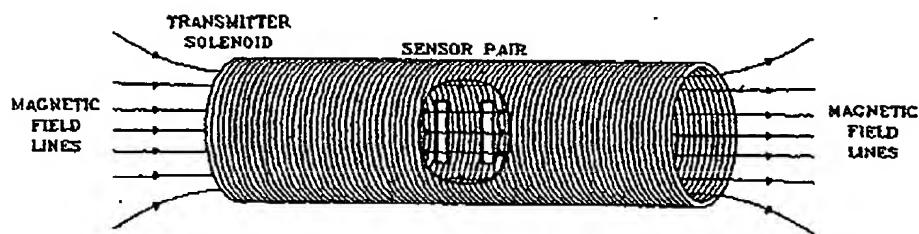


FIGURE 1-8  
SENSOR PAIR CALIBRATION  
USING A LARGE SOLENOID COIL

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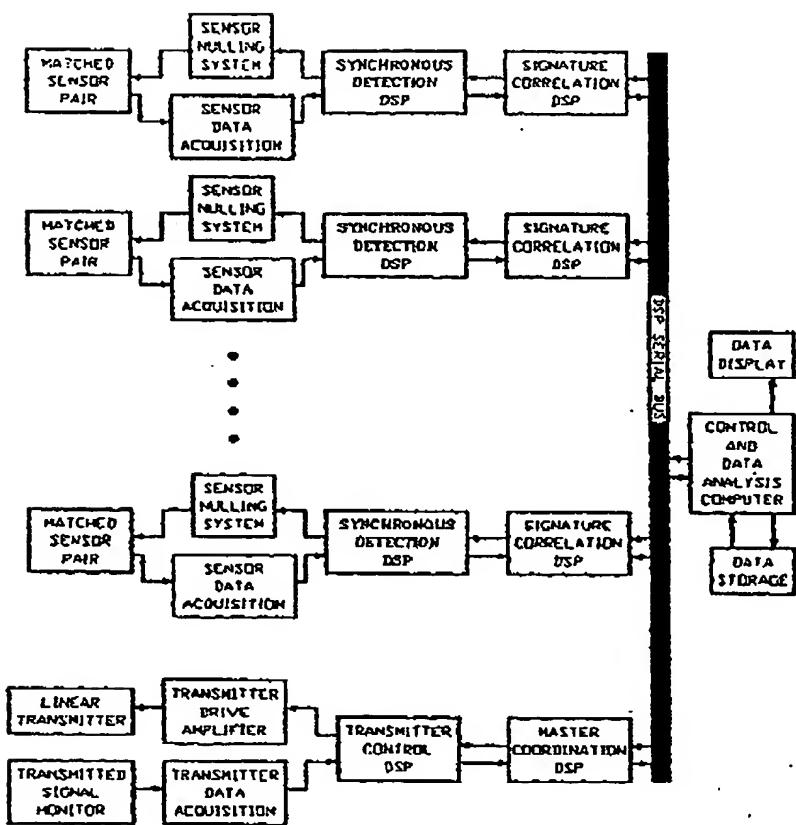


FIGURE 1-9  
SYSTEM WITH MULTIPLE SENSOR PAIRS  
AND SYNCHRONOUS DETECTION  
BASED ON DSP PROCESSORS

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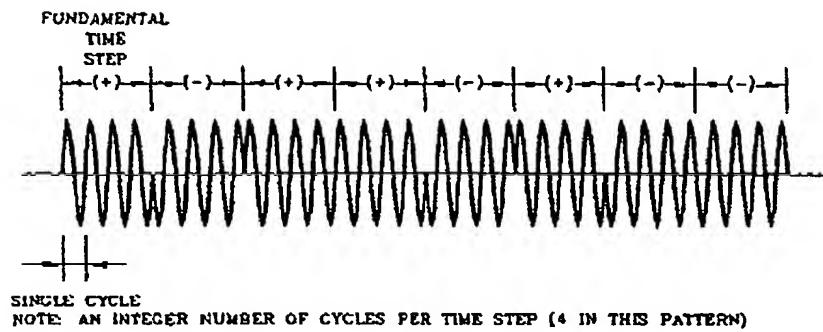


FIGURE 1-10  
AN 8 SECTION (+ - + + - + - - )  
TIME ENCODED WAVEFORM

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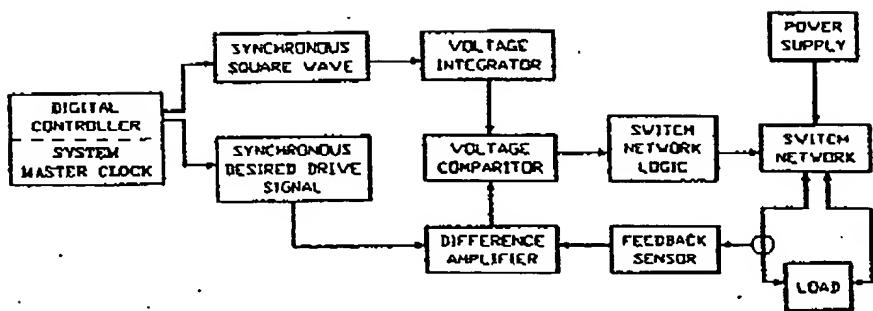


FIGURE 2-1  
SYNCHRONOUS PULSE WIDTH MODULATION AMPLIFIER

U.S. Patent Application Serial No. 10/827,089  
Filed: April 19, 2004, Inventor: James Wagner Larsen  
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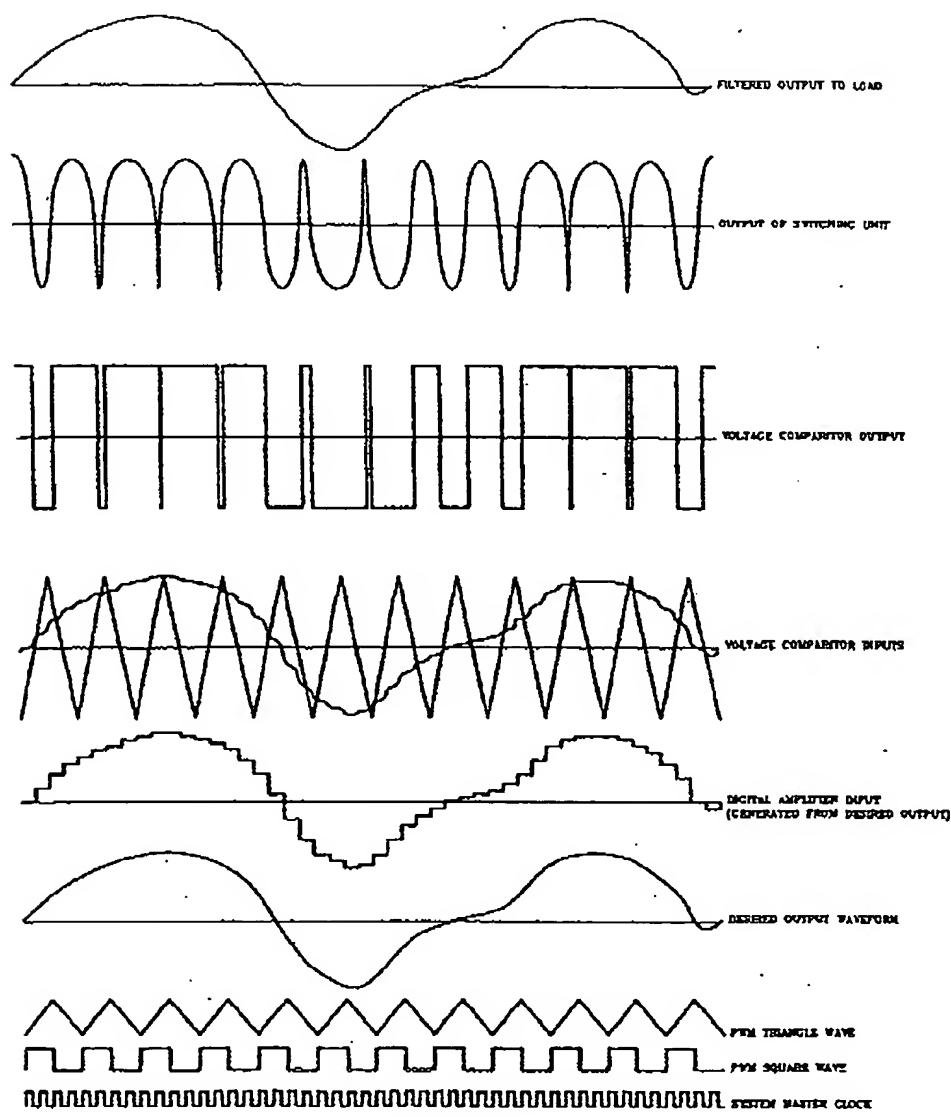


FIGURE 2-2  
TYPICAL PULSE WIDTH MODULATION WAVEFORMS

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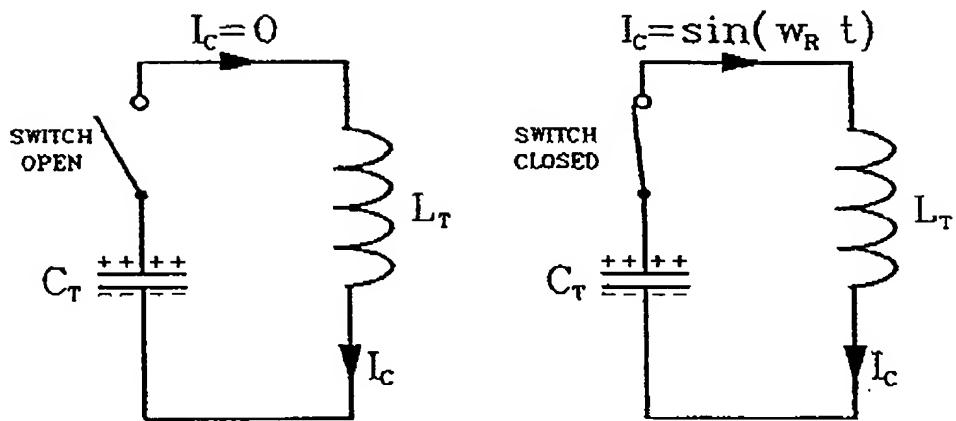


FIGURE 4-1  
WHEN SWITCH IS CLOSED CIRCUIT OSCILLATES  
AT RESONANT FREQUENCY,  $w_R$

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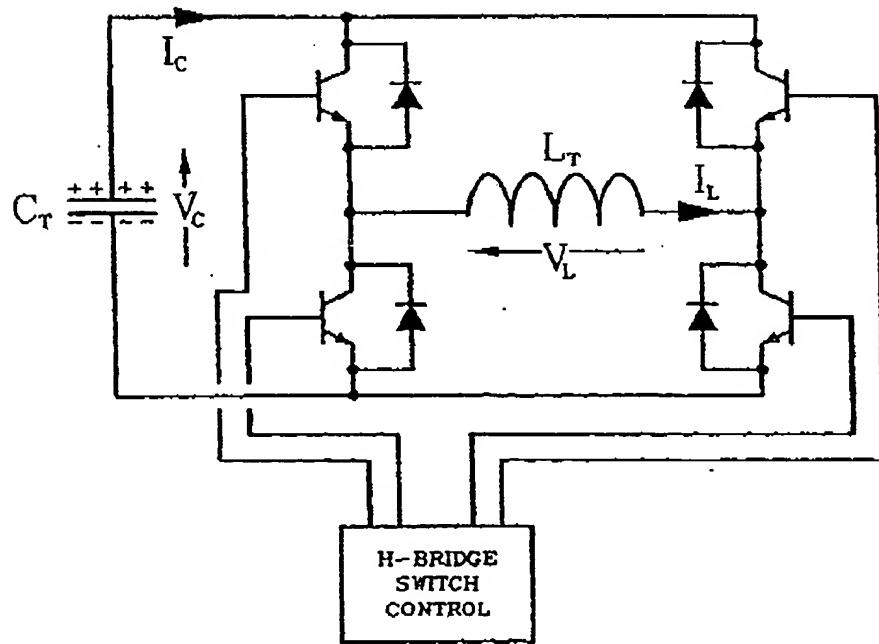


FIGURE 4-2  
AN H-BRIDGE SWITCH NETWORK  
CONNECTING THE CHARGED CAPACITOR  
TO THE LOAD COIL

U.S. Patent Application Serial No. 10/827,089  
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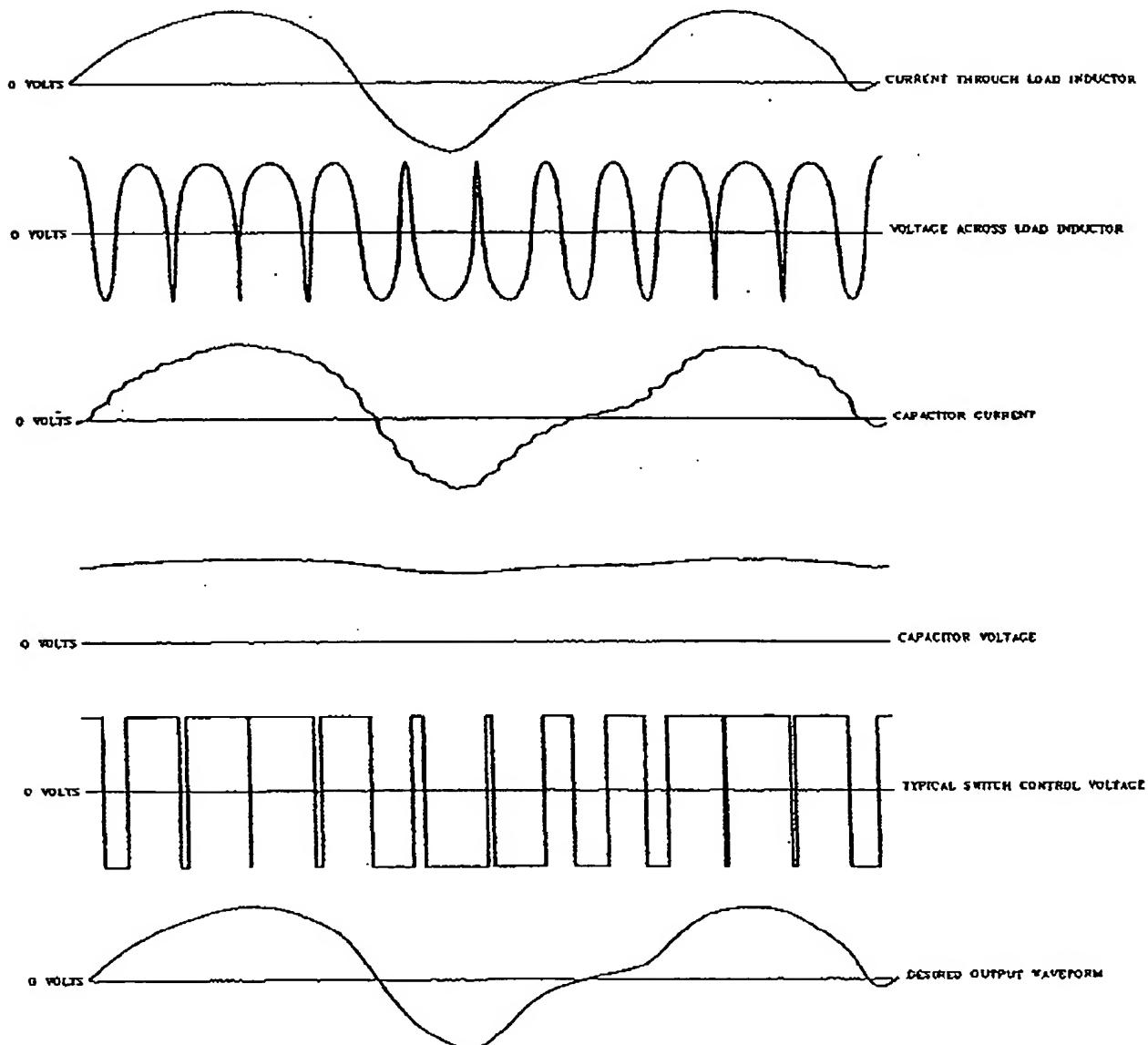


FIGURE 4-3  
SWITCHED CAPACITOR CIRCUIT WAVEFORMS

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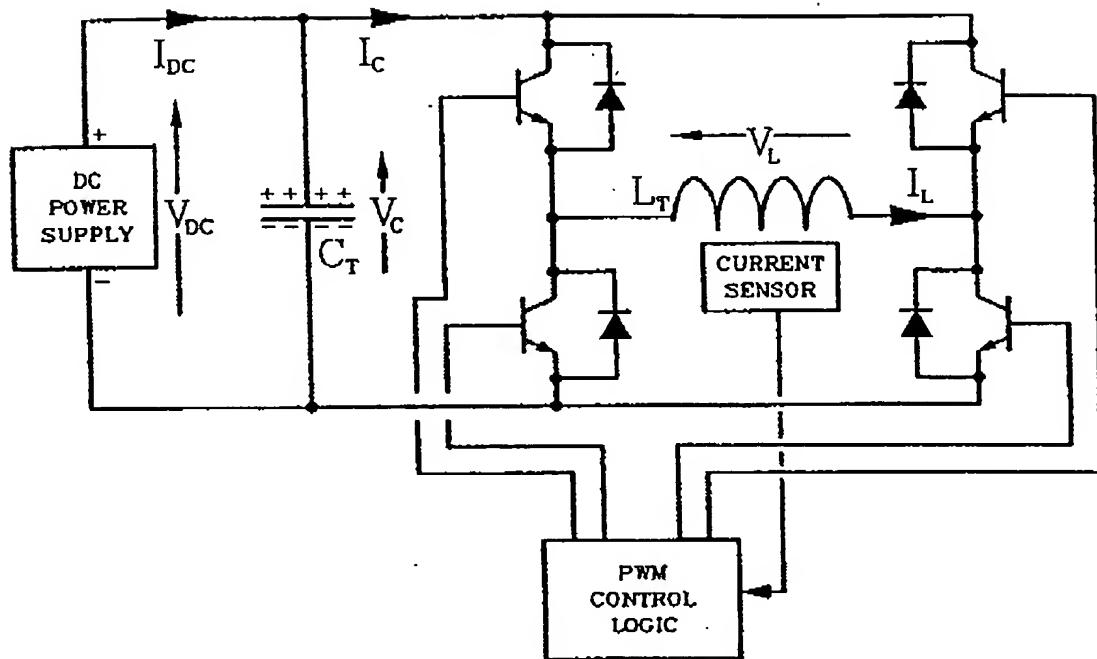


FIGURE 4-4  
PULSE WIDTH MODULATED  
SWITCHED CAPACITOR RESONATOR

U.S. Patent Application Serial No. 10/827,089  
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 Attorney Docket No. 14085/299978  
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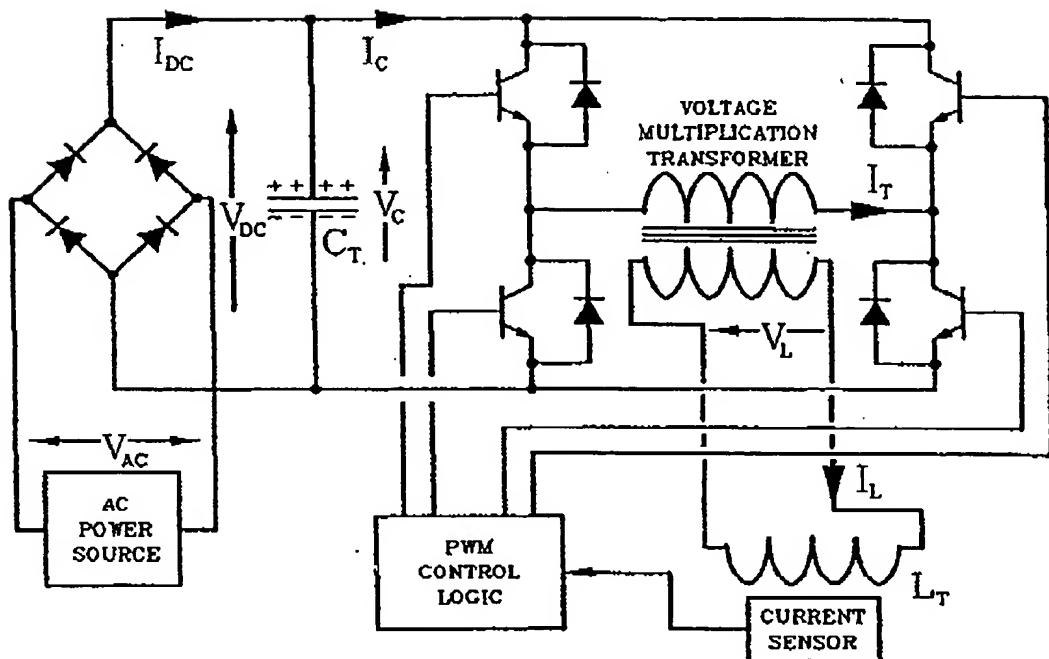


FIGURE 4-5  
 SWITCHED CAPACITOR RESONATOR  
 WITH INTEGRAL SWITCHING POWER SUPPLY

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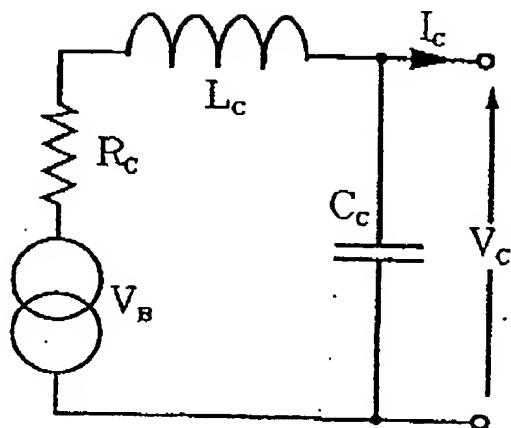


FIGURE 5-1  
SENSE COIL EQUIVALENT CIRCUIT

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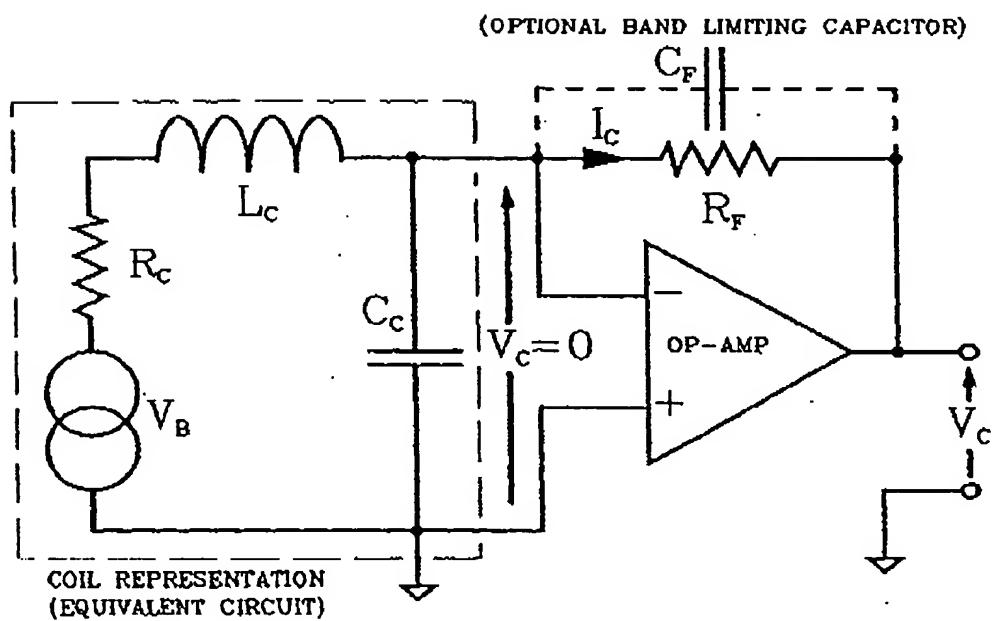
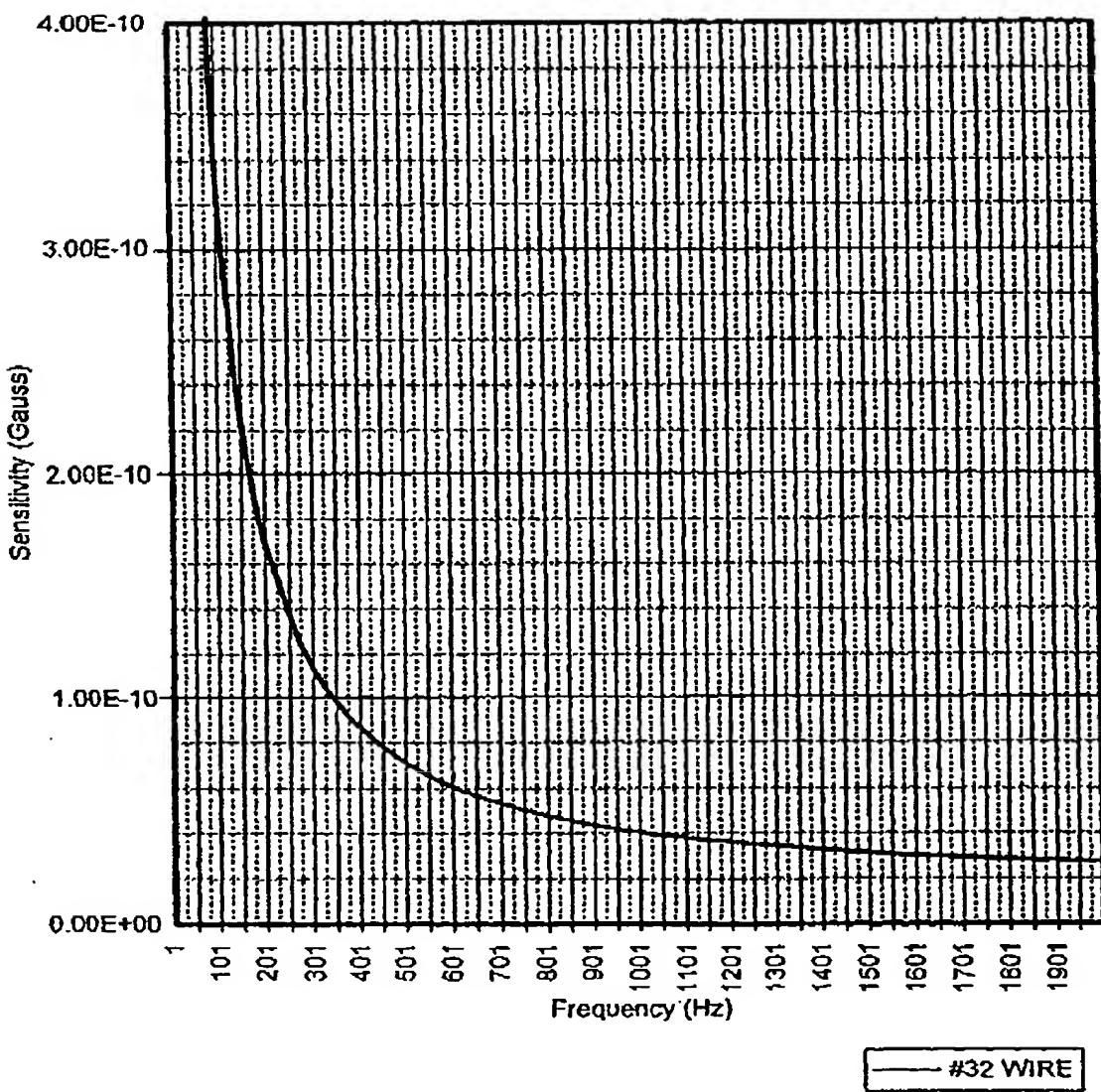


FIGURE 5-2  
 OPERATIONAL AMPLIFIER BASED  
 VOLTAGE TO CURRENT CONVERSION CIRCUIT

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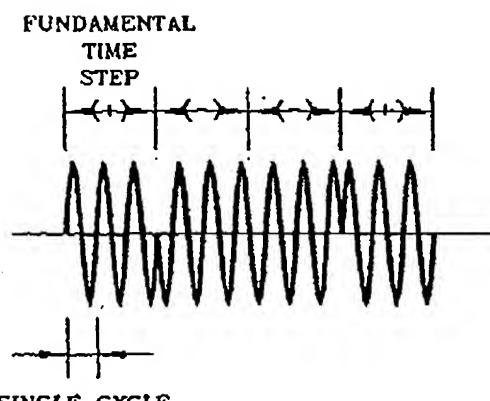
## SENSITIVITY FOR #32 WIRE WITH Rf+10MOhm



#32 WIRE

FIGURE 5-3

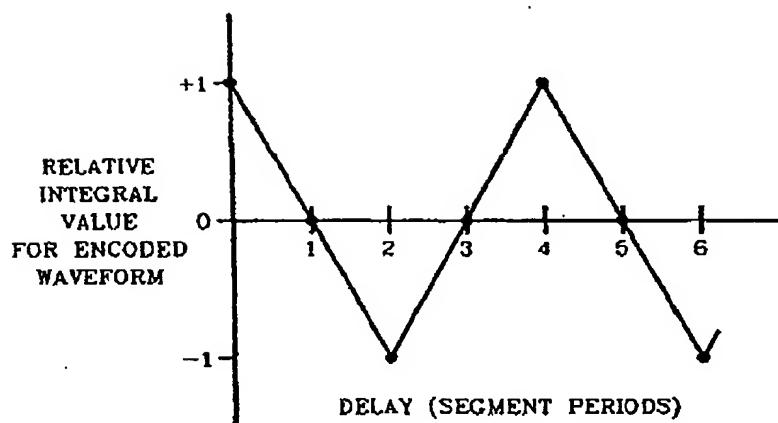
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NOTE: AN INTEGER NUMBER OF CYCLES PER TIME STEP  
(3 IN THIS PATTERN)

FIGURE 6-1  
A 4 SEGMENT (+ - - +)  
TIME ENCODED WAVEFORM

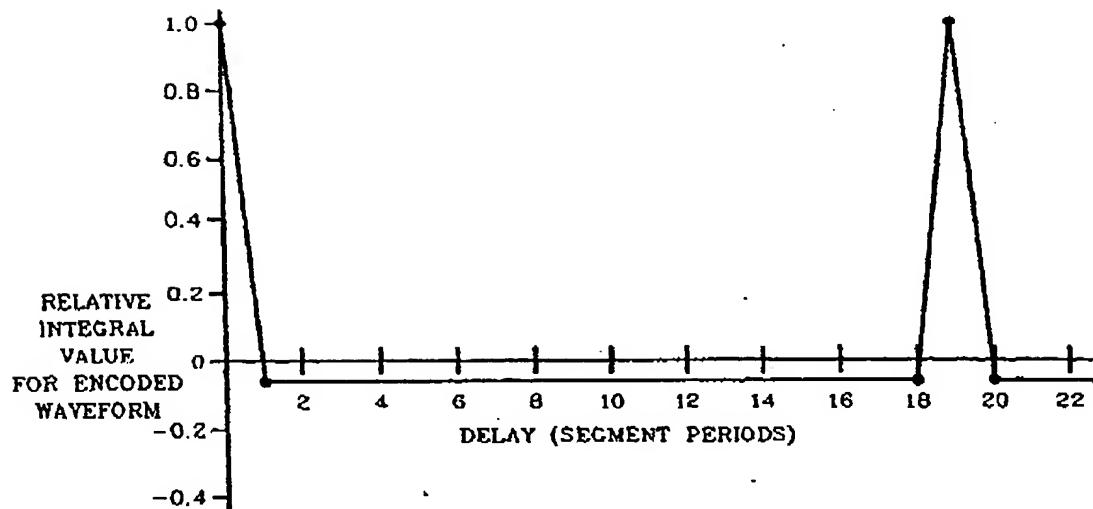
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NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS ZERO

FIGURE 6-2  
CORRELATION OF THE 4 SEGMENT (+ - - +)  
ENCODED WAVEFORM WITH ITSELF

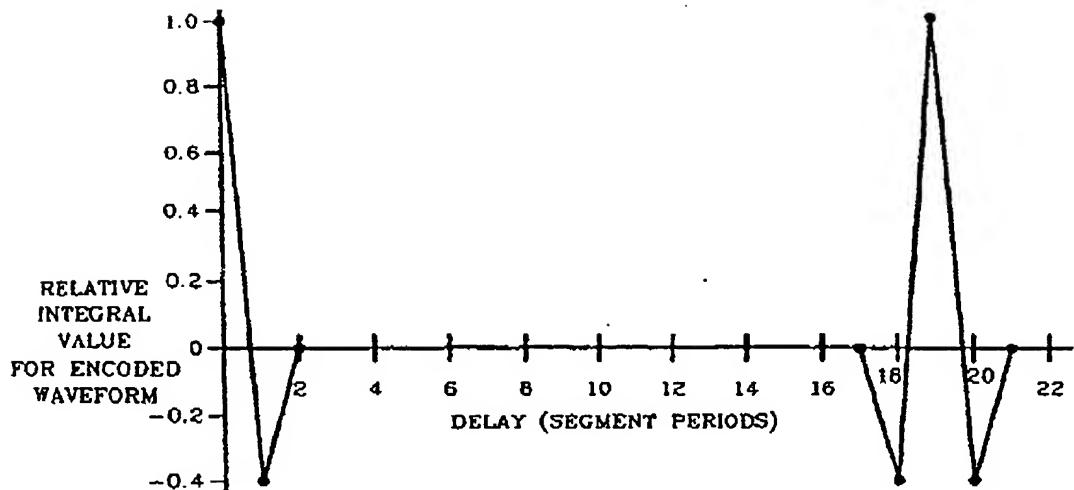
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NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS 0.0526

FIGURE 6-3  
CORRELATION OF THE 19 SEGMENT  
(++++-++-++-+---+-+)  
ENCODED WAVEFORM WITH ITSELF

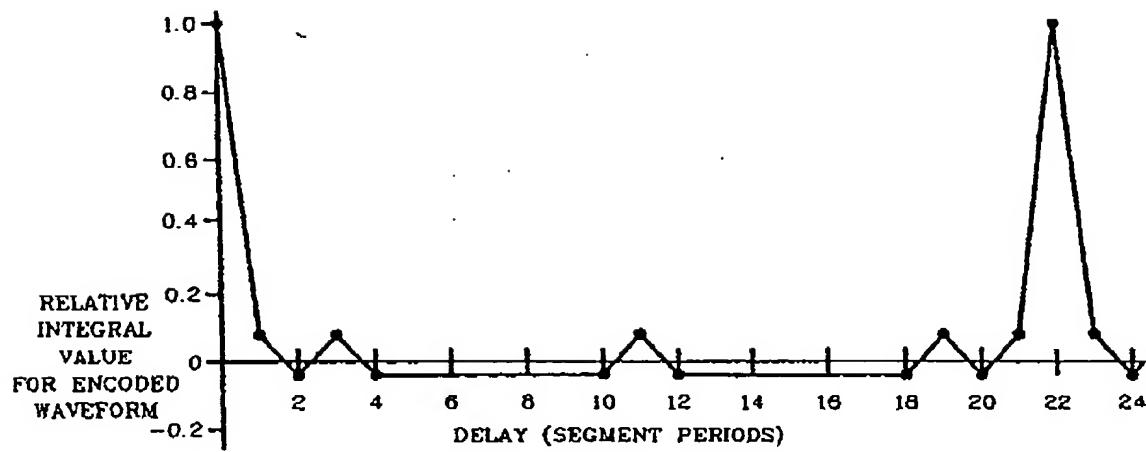
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NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS -0.1

FIGURE 6-4  
CORRELATION OF THE 20 SEGMENT  
(+---++--+---+--++-+--+-)  
ENCODED WAVEFORM WITH ITSELF

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NOTE: THE INTEGRAL OF THIS WAVEFORM WITH A CONTINUOUS SINE WAVE IS ZERO

FIGURE 6-5  
CORRELATION OF THE 22 SEGMENT  
(++++---+---+--+++-+--++-)  
ENCODED WAVEFORM WITH ITSELF

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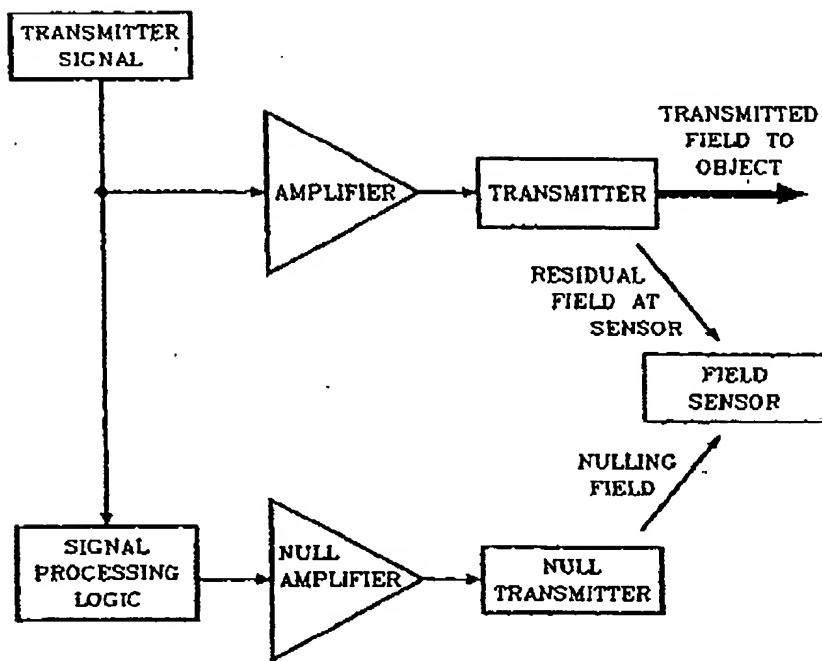


FIGURE 7-1  
LOCAL MAGNETIC FIELD GENERATION  
FOR RESIDUAL FIELD CANCELLATION

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